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THE UTILITY OF REMOTE SENSING DATA FOR LAND
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DETERMINATION OF THE UTILITY OF REMOTE
SENSING DATA FOR LAND USE/COVER ANALYSES
IN THE LOWER APPALACHIA REGION -- ASSESSING
THE UTILITY OF REMOTE SENSING DATA FOR
ARCHEOLOGICAL SITE RECOGNITION

CONTRACT NAS13-200

FINAL REPORT

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Mid-America Remote Sensing Center
Murray State University

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Abstract

Thematic Mapper Simulator (TMS) data were gathered by NASA/ERL over a portion of the lower Ohio River and the middle Mississippi River valleys on April 11, 1982. CIR imagery accompanied the 10 and 30 meter resolution TMS data sets. This area is somewhat unique archeologically as there exists a concentration of sites with major features such as mounds, earthworks, and villages. It was the primary purpose of this study to determine the utility of TMS data in identifying signatures which are distinctly archeological. TMS data were processed using the NASA/ERL software package ELAS. No signatures that were distinctly archeological were detected, due in large part to the complexity of the land cover and land use practices. However, as more sophisticated classification techniques were employed, the classes which were related to archeological features were narrowed. TMS data could certainly be of assistance to a trained archeologist/interpreter in narrowing an area which has to be field-surveyed as anomalous features can be recognized within a particular environmental context.

Introduction

The lower Ohio River valley and the middle Mississippi River valley were major areas of concentrations of prehistoric peoples as is true with respect to portions of other major river corridors. This area is somewhat unique, however, in the fact that not only do two major river arteries in North America meet in this area, but that two other significant rivers, the Tennessee and the Cumberland, also converge in this region. A concentration of major river arteries and a hospitable environment with fertile alluvial soils, dense upland forest tracts and abundant wildlife of many species offered a situation which allowed for a rather dense population concentration during prehistoric times.

Associated with this concentration of prehistoric peoples are a variety of remnant structural features including mounds, earthworks, house platforms and village sites. Some of these features are of a size which might allow them to be detected by the Thematic Mapper Simulator (TMS) at 10 meter and/or 30 meter resolution.

TMS data were gathered along the lower Ohio and middle Mississippi

River corridors by NASA under NAS13-200 on April 11, 1982. Color infrared (CIR) photography also accompanied the 10 meter and 30 meter TMS data sets.

Purpose

The primary purpose of this study was to determine the utility of seven-channel TMS data in the detection of signatures which are specific with respect to archeological features, namely larger structures such as mounds, earthworks, areas of midden, etc. These features would necessarily have to be of an extent greater than 10 meters, the maximum resolution of the TMS. The study was primarily focused upon the utilization of 10 meter TMS data although 30 meter data was utilized over sites where the greater resolution was not available.

Study Area: Location and Condition at Flight Time

The study area includes the floodplain and adjacent upland environments along the lower Ohio River in Kentucky and Illinois from the junction of the Tennessee River to the mouth of the Ohio and from that point southward along the Mississippi River to the Tennessee border. All sites chosen for study are located in Kentucky, with the exception of the Kincaid site complex (11MxV1/11PpV1) which is located in Illinois (Figure 1).

At the time that the CIR and TMS data were gathered, April 11, 1982, the region was in a time of seasonal transition with respect to natural vegetative growth and agricultural practices. Grassland and/or pastureland areas were in early growth stages and stage of growth varied with respect to species. This was also true with respect to forest cover as some species were beginning to leaf while others displayed no leaves. The stage of agricultural land also varied greatly depending upon the

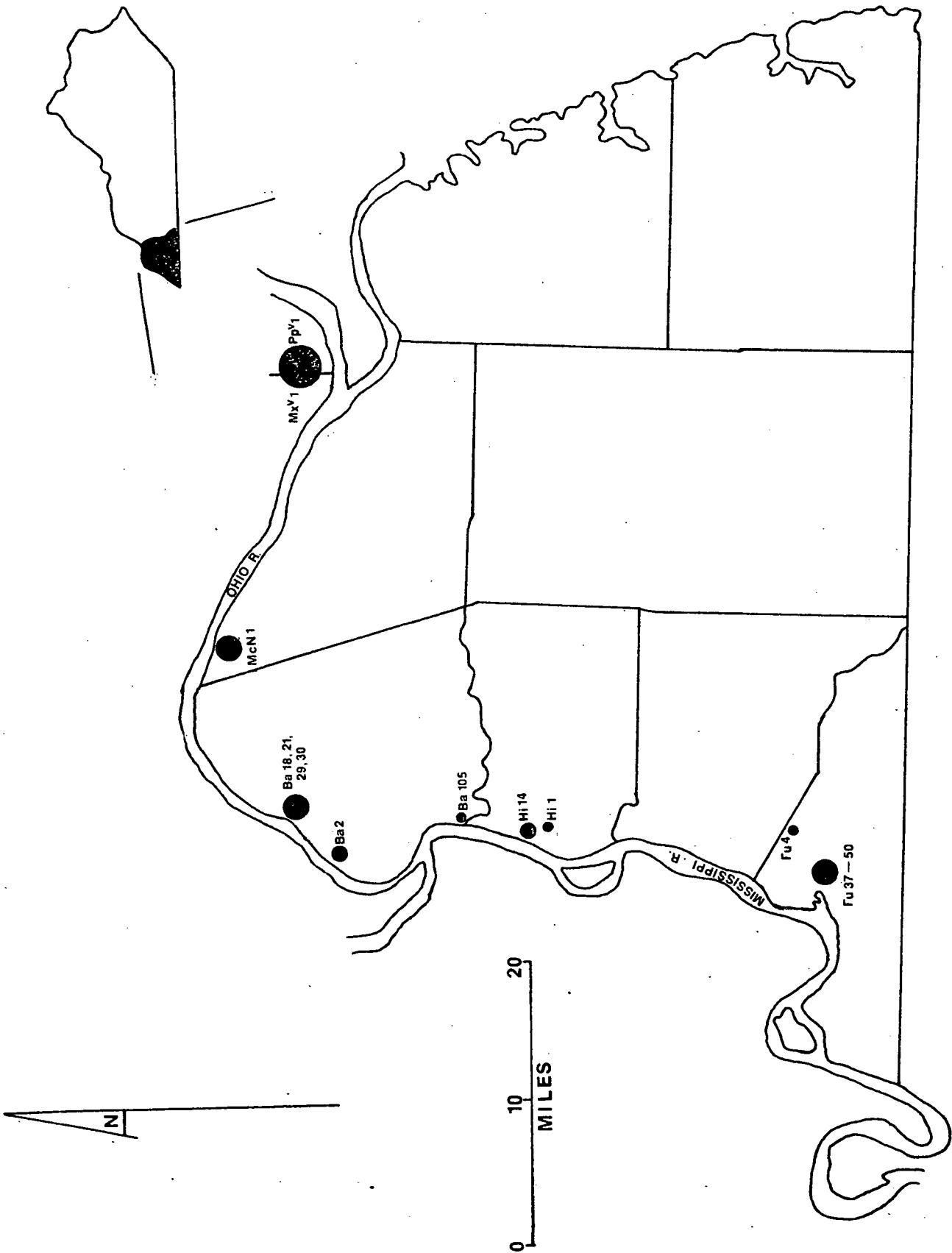


Figure 1. Study Area and Site Locations

cropping practices used. Some land had been plowed in the fall and lay bare over the winter. Other ground had been tilled recently. Some areas had been no-tilled with attendant stubble from the past fall remaining in the fields. Other fields which had been plowed in the fall or no-tilled showed various densities of weeds. The only crop at a visible growth stage was winter wheat which gave a wide variety of responses due to differences in variety, available moisture, and fertilization practices.

The conditions mentioned above are those found in association with the archeological sites considered in this study. They are obviously not optimum when trying to distinguish signatures which are distinctly archeological. To accomplish this with data which is reflective in nature may be very difficult in a region where patterns are very complex throughout the year.

General Methodology

The following is a general description of the overall methodology for the study:

1. Flight lines were determined on the basis of a knowledge of the location of archeological sites in western Kentucky. Flight lines were chosen that would include the maximum number of major known sites. This information was obtained from 1:24000 USGS topographic maps with site locations marked. This information was housed in the Murray State University Archeology Laboratory. Site information was also obtained through the Office of State Archeology which possesses a database of sites within the Commonwealth of Kentucky.
2. NASA/ERL flew the necessary flight lines on April 11, 1982, gathering TMS data at 10 and 30 meters with accompanying CIR.

3. The research group at Murray State University studied in detail the major sites within the study area (Table 1). This process included field reconnaissance, literature search, review of the archeological site database provided by the Office of State Archeology, and the locating of those sites on USGS 1:24000 quadrangles.

TABLE 1: Archeological Sites, Locations, and Flight Lines

| State Designation | Local Name | County | State | Flight Line ¹ |
|---------------------|------------------------------------|-----------|-------|--------------------------|
| 15Ba2 | Twin Mounds | Ballard | KY | 1 |
| 15Ba18,21,29,30 | Mitchell Lake Complex | Ballard | KY | 1 |
| 15Ba105 | Westvaco | Ballard | KY | 1 |
| 15Fu4 | Adams Mound Group | Fulton | KY | 2 |
| 15Fu37-50 | O'Byam's Fort and Stahr Hill | Fulton | KY | 2 |
| 15Hi1 | McCleod's Bluff | Hickman | KY | 2 |
| 15Hi14 | Bluff Site | Hickman | KY | 2 |
| 15McN1 | Shawnee Mounds | McCracken | KY | 1 |
| 11Mx ^V 1 | Kincaid Mound Complex (west 1/3) | Massac | IL | 1 |
| 11Pp ^V 1 | Kincaid Mound Complex (east 2/3's) | Pope | IL | 1 |

¹Sites were located along two flight lines. Flight Line 1 extended along the Ohio River from the junction of the Tennessee River to a point near the mouth of the Ohio. Flight Line 2 extended from the junction of the Ohio and Mississippi Rivers southward along the Mississippi River to the Tennessee border.

4. Sites were located on CIR imagery and visually interpreted with respect to their characteristic structures and cover types.
5. The sites were located on both 10 and 30 meter TMS raw data channels by scan and element.
6. TMS data were digitally processed using the NASA/ERL software package ELAS.
7. The results of the aforementioned processing were analyzed and conclusions were formulated.

Archeological Site Description

The following is a description of the sites which were included in the study. This information was obtained from literature, field experience, and information obtained from the database of the Kentucky State Archeologist. All sites were subjected to Steps 3-7 above. However, those marked with an asterisk (*) received a greater degree of indepth digital processing. These sites were deemed to show the best examples of specific site characteristics, e.g., bare ground mounds, vegetation vigorously growing on midden, tree-covered mounds and other structures. They were considered to be "type" sites for this region because of their physical attributes. The information presented for each site consists of location (generalized and center point UTM coordinates); physical characteristics (including land form, spatial distribution, and structural components); temporal placement based on presence/absence of certain cultural traits; and cultural affiliation (including site significance).

Site 15Ba2 (Twin Mounds)

Site 15Ba2, also known locally as the Twin Mounds, is a medium size

(35 hectares) Mississippian village site with two associated mounds (Table 2). The site is located within the Barlow Bottoms and is clearly marked on the Cairo, Illinois topographic 1:24000 quadrangle. The center point location of 15Ba2 is UTM Zone 16, 4104330 Northing, 309380 Easting.

The internal composition of this site consists of three major areas: ceremonial mounds; central plaza; and living or habitation areas (Figure 2). The ceremonial mounds are located within the northern one-third of the site area. The largest of the two mounds is about 3.5 hectares (basal dimension) and is between six and eight meters in height. Both mounds are truncated (flat-topped), but only the larger of the two mounds has vestiges of a ramp that is located on the southwestern side of the large mound. The smaller mound has a basal dimension of about 2.5 hectares and is between six and eight meters in height.

Immediately to the south of both mounds is a five hectare area in which no cultural materials are present (structural or artifactual). Although none of this site has been excavated, it is assumed through analogy that this particular "sterile" area is a plaza, which was probably kept clean by the site's inhabitants. Such was a common practice at most Mississippian Tradition settlements.

Adjacent to, but extending from the southwest to northeast periphery of the central plaza, is a very dark soil (midden) area containing much prehistoric cultural debris (especially Mississippian shell-tempered ceramic types, burned sandstone, burned clay, human and non-human animal bone, and burned and unburned daub and chert detritus). Concentrations of artifactual materials are readily observed in this area of the site at about five meter intervals, with each concentration covering an area of about three or four meters. More than likely, each "concentrated"

Table 2: General Characteristics of Sites

| SITE NO. | CENTER POINT UTM COORDINATES, ZONE 16 (Northing) (Easting) | | 1:24000 TOPOGRAPHIC QUADRANGLE MAP | SITE TYPE | CULTURAL TRADITION | DATE RANGE |
|----------|--|--------|---------------------------------------|--|-----------------------|--------------------------|
| 15Ba2 | 4104330 | 309380 | Cairo, Illinois | Large village w/mounds, plaza and house units w/midden | Mississippian | A.D. 1250 - A.D. 1350 |
| 15Ba18 | 4114900 | 318925 | Olmstead, Illinois | Seasonal base camp w/midden | Archaic | 8000- 6000 B.C. |
| 15Ba21 | 4113750 | 318950 | Olmstead, Illinois | Single household unit w/o midden | Woodland | A.D. 600 - A.D. 900 |
| 15Ba29 | 4114100 | 318950 | Olmstead, Illinois | Single household unit w/o midden | Woodland | A.D. 600 - A.D. 900 |
| 15Ba30 | 4114375 | 319600 | Olmstead, Illinois | Single household unit w/o midden | Woodland | A.D. 600 - A.D. 900 |
| 15Ba105 | 4090460 | 313900 | Wickliffe, Kentucky | Small village w/midden and w/o mounds | Mississippian | A.D. 1250 - A.D. 1350 |
| 15Fu4 | 4052470 | 311800 | Cayce, Kentucky | Medium village w/mounds, midden, plaza, and house units | Mississippian | A.D. 1100 - A.D. 1250 |
| 15Fu37 | 4050300 | 306840 | Hickman, Kentucky | Earthwork | Woodland | 300 B.C. - A.D. 300 |
| 15Fu38 | 4050070 | 306440 | Hickman, Kentucky | Mound (destroyed) | Woodland | 300 B.C. - A.D. 300 |
| 15Fu39 | 4050100 | 306900 | Hickman, Kentucky | Mound (destroyed) | Woodland | 300 B.C. - A.D. 300 |
| 15Fu40 | 4050390 | 307080 | Hickman, Kentucky | Mound | Woodland | 300 B.C. - A.D. 300 |
| 15Fu41 | 4050560 | 307145 | Hickman, Kentucky | Two mounds | Woodland | 300 B.C. - A.D. 300 |
| 15Fu42 | 4050660 | 307200 | Hickman, Kentucky | Mound | Woodland | 300 B.C. - A.D. 300 |

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Table 2: General Characteristics of Sites (cont'd)

| SITE NO. | CENTER POINT UTM COORDINATES, ZONE 16 (Northing) (Easting) | | 1:24000 TOPOGRAPHIC QUADRANGLE MAP | SITE TYPE | CULTURAL TRADITION | DATE RANGE |
|-------------|--|------------------|---|---|-----------------------|--------------------------|
| 15Fu43 | 4050470 | 307300 | Hickman, Kentucky | Mound | Woodland | 300 B.C. - A.D. 300 |
| 15Fu44 | 4050565 | 306620 | Hickman, Kentucky | Mound | Woodland | 300 B.C. - A.D. 300 |
| 15Fu45 | 4050400 | 306400 | Hickman, Kentucky | Large village w/o mounds or plaza but w/midden | Mississippian | A.D. 1100 - A.D. 1250 |
| 15Fu46 | 4050660 | 306300 | Hickman, Kentucky | Isolated house unit w/o midden | Mississippian | A.D. 1100 - A.D. 1250 |
| 15Fu47 | 4050660 | 306500 | Hickman, Kentucky | Isolated house unit w/o midden | Mississippian | A.D. 1100 - A.D. 1250 |
| 15Fu48 | 4050100 | 306520 | Hickman, Kentucky | Small village | Woodland | 300 B.C. - A.D. 300 |
| 15Fu49 | 4050120 | 306680 | Hickman, Kentucky | Small village | Woodland | 300 B.C. - A.D. 300 |
| 15Fu50 | 4050040 | 306820 | Hickman, Kentucky | Small village | Woodland | 300 B.C. - A.D. 300 |
| 15Hi1 | 4059420 | 310380 | Oakton, Kentucky | Medium village w/mounds, plaza, and midden | Mississippian | A.D. 1250 - A.D. 1350 |
| 15Hi14 | 4062360 | 310340 | Oakton, Kentucky | Very large village w/o mounds | Woodland | 300 B.C. - A.D. 900? |
| 15McN1 | EAST 4114480 WEST 4115250 | 337960 336850 | Joppa, Ill. - Ky. | Mounds | Woodland | A.D. 600 - A.D. 900 |
| 11MxVa/PpV1 | 4104600 | 367200 | Paducah East, Ky. and Little Cypress Creek, Ky. | Extremely large urban center w/stockades, mounds, plaza, house units, garden plot and midden | Mississippian | A.D. 1250 - A.D. 1350 |

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Figure 2. CIR of 15Ba2

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area represents the location of individual house units that were organized in typical nucleated (as opposed to dispersed) Mississippian fashion.

Based on the type artifacts observed while ground truthing this site, 15Ba2 probably dates from the Middle to Late period within the Mississippian cultural tradition (ca., A.D. 1250 to 1350).

Sites 15Ba18, 21, 29, and 30 (Mitchell Lake Complex)

This concentration of prehistoric sites is located along the northwestern (15Ba18) and eastern (15Ba21, 29, and 30) terraces along Mitchell Lake, a former channel of the Ohio River. Other than very general information, none of these sites has been described in the literature. The entire Mitchell Lake complex of sites is visible on the Olmstead, Illinois-Kentucky 1:24000 topographic quadrangle.

The UTM center point location for site 15Ba18 is Zone 16, 4114900 Northing, 318925 Easting. This site had been plowed recently and was in excellent condition for surface survey when it was ground truthed in February of 1983. The site area is delineated by a very pronounced dark midden soil stain that covers an area of about 2.5 hectares (Figure 3).

Although the site rests on a small, severely-eroded terrace, the site is not an "Indian Mound" as has been referenced by local informants. Cultural materials on the site's surface consist exclusively of lithic items (ground and chipped stone and fire-cracked rock), including an Early Archaic period (8000-6000 B.C.) projectile point form. The absence of post-Archaic cultural materials (i.e., ceramics) and the presence of temporally-diagnostic cultural materials suggests that site 15Ba18 may date to the early part of the Archaic Tradition.

The presence of midden stains indicates that this site was used

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Figure 3. CIR of Ba18, 21, 29, 30. (North is at top of page)

intensively by its inhabitants, but that its occupation was probably limited to seasonal base camp activities (e.g., fall hunting/fishing activities). No permanent structures (i.e., houses) are known to have been used during the Early Archaic period in the eastern United States, however, the presence of fire-cracked rock and considerable quantities of chipped stone detritus do indicate that the site contains internal structural components (features), i.e., hearths, knapping stations, and probably refuse and/or storage pits. Of the Mitchell Lake site complex, site 15Ba18 is probably the most significant site, because it is the only known Early Archaic "midden" site in the eight county Jackson Purchase region.

Sites 15Ba21, 29, and 30, are all located on small, elevated silty areas associated with an old Ohio River terrace that now overlooks Mitchell Lake. The center point UTM coordinate for each of these sites, which are all within Zone 16, are: 4113750 Northing and 318950 Easting for Ba21; 4114100 Northing and 318950 Easting for Ba29; and 4114375 Northing and 319600 Easting for Ba30. Each of these sites are spaced about 200 to 300 meters apart (southwest to northeast), and each probably represents a non-nucleated, dispersed, Late Woodland (ca., A.D. 600 to 900) household. Although each site unit would have been represented by at least one wattle and daub structure (house constructed of clay and cane; probably with thatched roof), no vestiges of other structures were present on the surface of the sites. No soil discolorations, midden deposits, or other signs of significantly intensive, permanent occupation (other than a few scatterings of chert debitage, ceramic sherds, and daub) were present. More than likely, this non-intensive Woodland Tradition settlement was seasonal and settlement probably occurred only after floodwaters receded from the Mitchell Lake slough so that fishing and other aquatic gathering activities could be pursued efficiently.

Site 15Ba105

Site 15Ba105 is located in extreme southwestern Ballard County, Kentucky (Wickliffe, Ky. 1:24000 topographic map), just north of Mayfield Creek and within the creek's floodplain zone at an elevation of about 97 meters. The UTM point location of this site is Zone 16, 4090460 Northing and 313900 Easting. Ground visibility at this site is poor, because the site area is used as a tree farm and intensive plowing of the understory growth (grasses) is not accomplished frequently.

Site 15Ba105 was actually "discovered" as a result of examining color infrared photography for this study. Unlike similar topographic areas within the Mayfield Creek bottoms, very positive growth responses can be seen in three contiguous areas (Figure 4). Ground truthing those areas revealed that the "hot spots" were prehistoric midden deposits. Based on the type of artifacts found within those areas, it is possible to assign site 15Ba105 to the late phase of the Mississippian cultural tradition (ca., A.D. 1250-1350). The total site area (combining the three midden areas) consists of about 15 hectares. No cultural materials were observed in the fields southeast of the midden deposits. Hence, in this particular example, the positive growth response in the midden areas delineate the spatial dimensions of this site quite accurately. More importantly, the hot spots represent excellent indirect examples of prehistoric signatures.

Site 15Fu4 (Adam's Mound Group)*

The Adam's Mound Group is located about nine kilometers northeast of Hickman in Fulton County, Kentucky. The site is situated on a 42 hectare elevated plateau within the Bayou de Chien floodplain. The center point UTM coordinates of this site complex, which is on the Cayce, Kentucky 1:24000 topographic quadrangle, is Zone 16, 4052470 Northing and 311800

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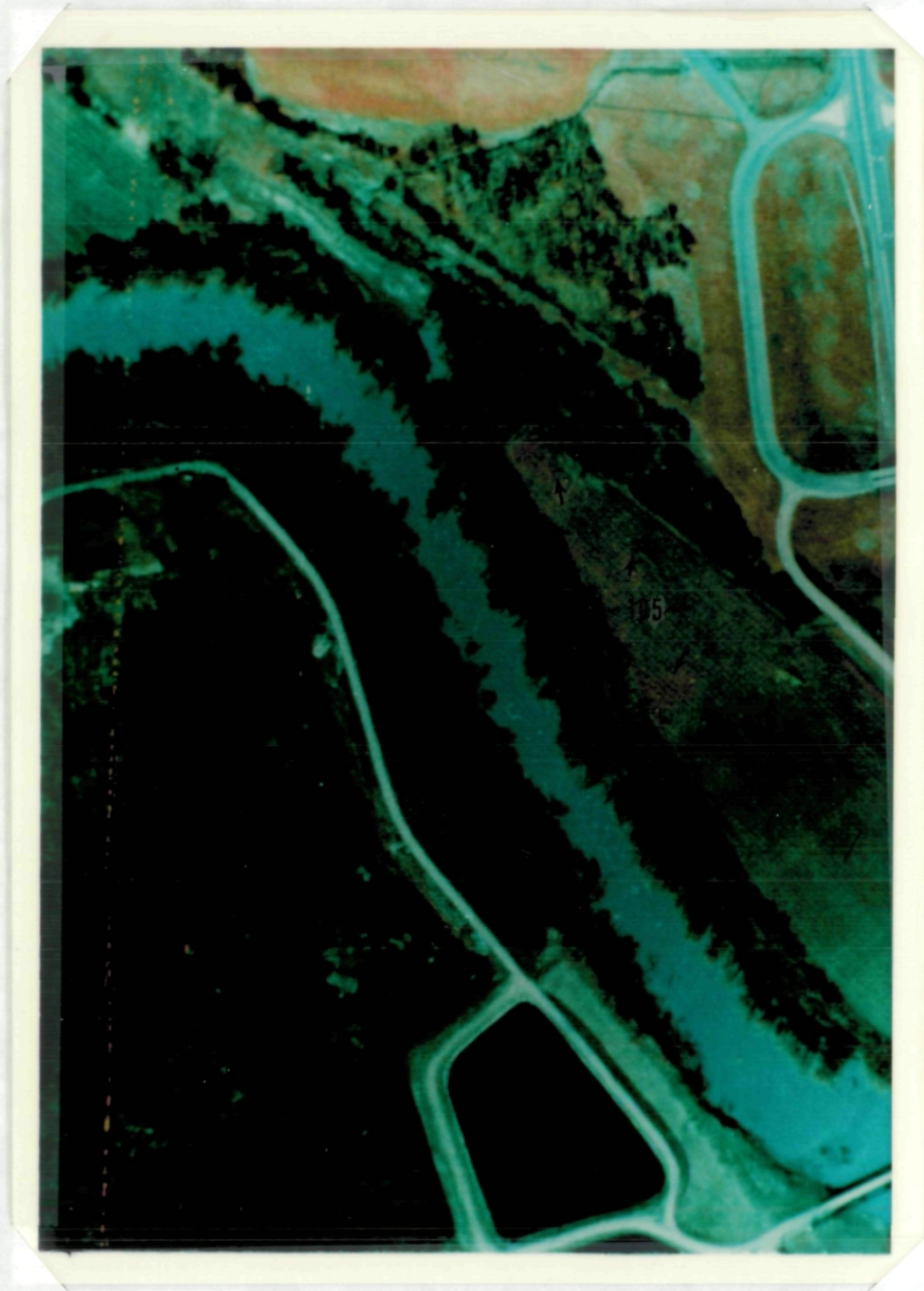


Figure 4. CIR of 15Ba105. (North is at top of page)

Easting. This site is an excellent example of the Middle Mississippian strategic settlement system, whereby the natural terrain was utilized to its fullest to make the site as defensible as possible. In the case of this particular site, either seasonal rainfall and flooding or torrential summer downpours would cause this site to be completely isolated.

The internal composition of this site exhibits much variation, but like most other Mississippian Tradition village complexes (e.g., McCleod's Bluff, Ancient Buried City, Twin Mounds, and Kincaid), the Adam's site is characterized by truncated temple mounds, habitation and midden areas, and a central plaza area (Figure 5).

Present within 15Fu4 are at least three mounds, several house platforms, a central plaza, and up to as much as 1.2 meters of midden deposits. Within the center of the site is the major, truncated temple mound with its ramp oriented toward the north. This major mound, which stands about eight meters above the village area, is flanked to the north by two lesser mounds that are about six meters in height. These mounds are adjacent to the south side of Bayou de Chien. The larger mound covers about 1.2 hectares as a basal dimension while the two smaller mounds cover only half as much area. Between these two mound areas is the central plaza, which is relatively void of artifacts and contains no evidence of midden deposits. The plaza area covers about 10 hectares. Surrounding the plaza region and flanking the mounds are several "incipient" mound platforms (which may be remnants of smaller mounds that have been plowed and eroded away) or house platforms. Their actual definition is not currently known. More than likely, these "mound platforms," which are about three to four meters square and elevated less than a meter, are strewn with utilitarian cultural materials, especially daub, animal bone, and broken ceramic vessels. Many of the latter frequently contain animal or human effigies, which are very

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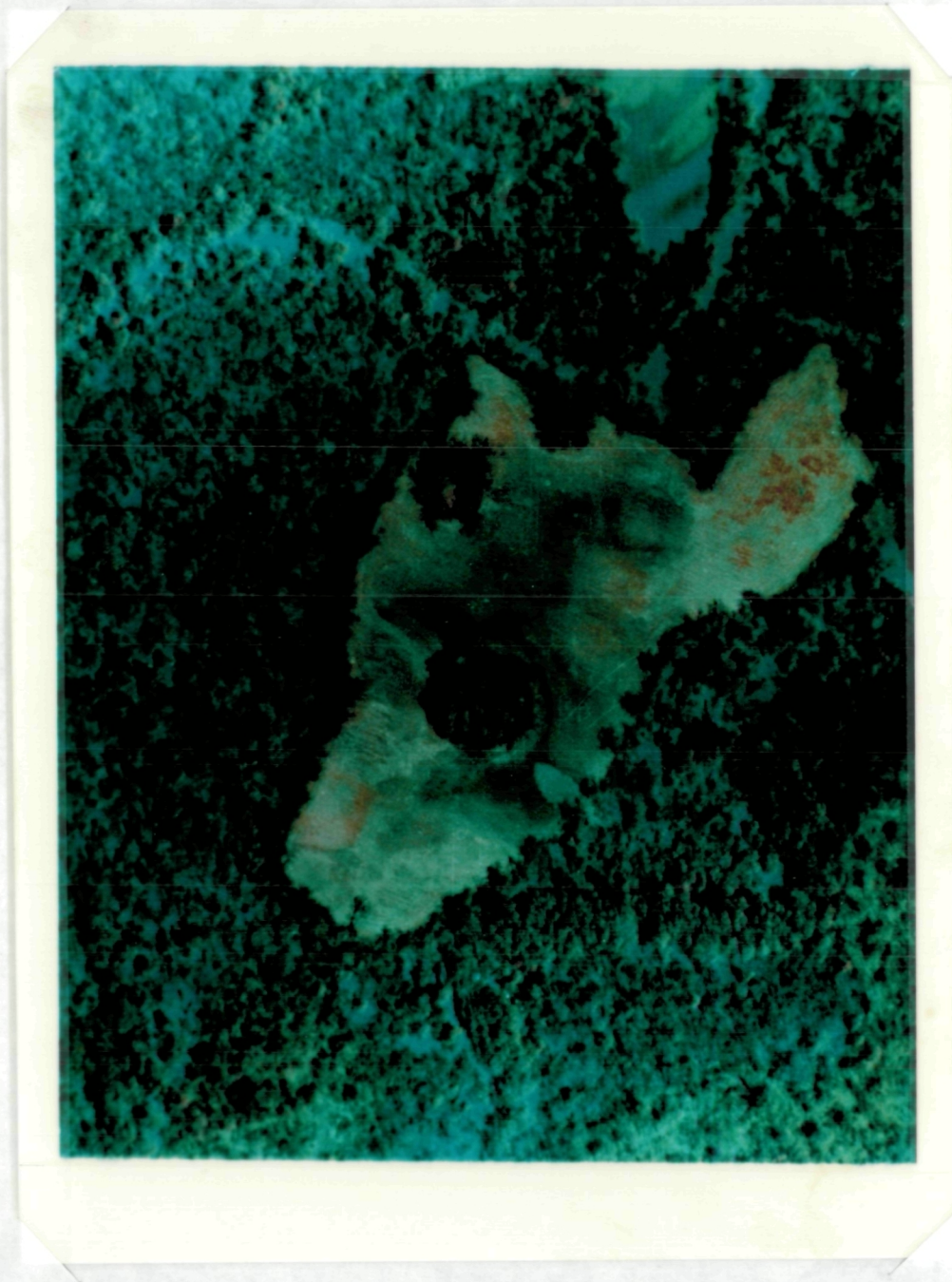


Figure 5. CIR of 15Fu4.

characteristic of the Middle Mississippian period (c.a., A.D. 1100-1250).

Unfortunately, this site is being looted at an alarming rate. Although probably less than 15 per cent of the total site area has been disturbed, the continued destruction of this very significant, national register quality site is an appalling reality. Of interest here, however, is that those areas of the site which were being looted in April of 1983 can be seen on the color infra-red photograph in Figure 5. On CIR imagery, looted areas appear as very dark red and yellow areas where the midden of the site has been brought to the site's surface. Hence, it may be possible for governmental agencies (e.g., National Park Service) to make use of CIR photography for the monitoring of archeological sites within large national parks. Evidence of site looting was not present on the 10 or 30 meter TMS data.

Sites 15Fu37 through 15Fu50 (O'Byam's Fort/Stahr Hill Complex)*

Sites 15Fu37 through 15Fu50 actually comprise two major, temporally-distinct, archeological sites with numerous structural components that overlap spatially (Figure 6). Areas designated 15Fu37 through 15Fu44 and 15Fu48 through 15Fu50 on Figure 7 collectively represent a single Middle Woodland site (ca., 300 B.C.-A.D. 300) that consists of three major components: earthwork, associated burial mounds, and village areas, respectively. These "sites" comprise the O'Byam's Fort site complex.

Sites 15Fu45 through 15Fu47 represent three spatially distinct areas of a very large Middle Mississippian habitation site that dates between A.D. 1100 and A.D. 1250. This site complex is known locally as "Stahr Hill."

The general location of the O'Byam/Stahr Hill site complex is 1.5 kilometers northeast of Hickman, Kentucky. A generalized UTM center

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Figure 6. CIR of 15Fu37-50. (North is at top of page)

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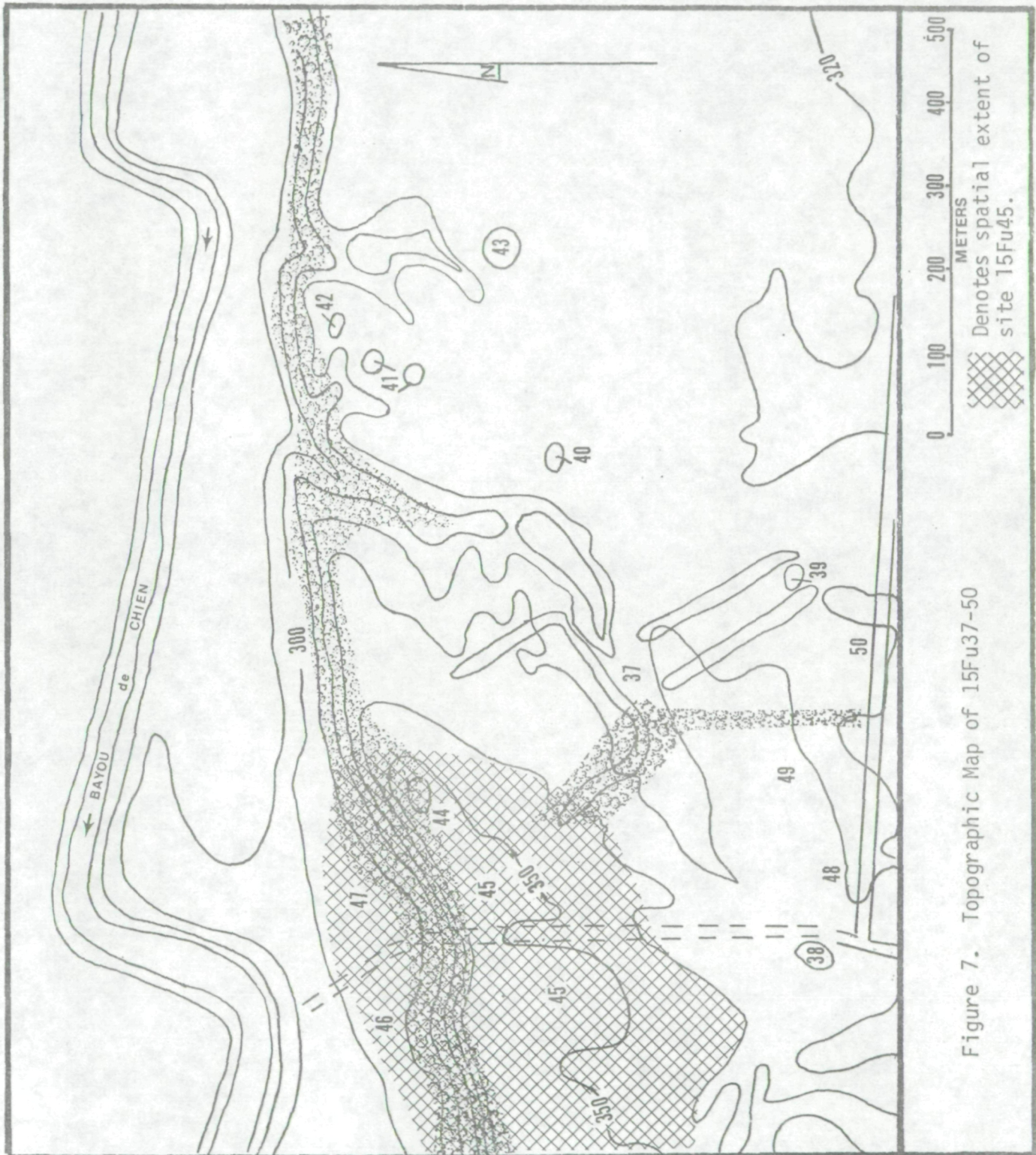


Figure 7. Topographic Map of 15Fu37-50

point of the "site" region is Zone 16, 4050300 Northing and 306840 Easting on the Hickman, Kentucky 1:24000 topographical quadrangle.

15Fu37 is an earthwork shaped like a tuning fork. The earthwork is oriented from southeast to northwest and is divided in half by what appears to be a naturally eroded ravine. The northern half of the earthwork is "U"-shaped. The area within its three-sided enclosure measures about 190 meters east-west by 170 meters north-south. Each prong of the earthwork is approximately eight to ten meters wide and rarely exceeds one to two meters above the surrounding terrain. The enclosure south of the ravine ("handle area"), is more narrow (40 meters wide) and is only 160 meters long.

Cultural materials which have been surface collected from inside, on top of, and adjacent to the outside margins of the earthwork consist almost entirely of two distinctive Middle Woodland ceramic wares (Mulberry Creek Cordmarked and Baumer/Crab Orchard Dowel Incised). These are the same ceramic wares that are present exclusively within the three village areas (15Fu48, 49, and 50) and the midden dumping area which is located just east of the northeast prong of the earthwork.

Sites 15Fu38 through 15Fu44 represent Middle Woodland burial mounds. Site 15Fu38 is referred to as the West Entry Mound; 15Fu39 is the Entry Mound; and 15Fu44 is the Alignment Mound, due to its relative position to 15Fu39. Site 15Fu41 is represented by two mounds of very similar size and shape. Mounds 38 and 39 have been almost entirely obliterated, however, it is still possible to determine their former spatial extent by conventional aerial photography. Their shape and size seem to have been very similar to the other mounds within the site complex, having a probable basal diameter of about six meters and an estimated height of two meters.

The O'Byam's Earthwork (and mounds and village complex) is the only Middle Woodland site complex known to exist within the eight-county Jackson Purchase region. However, other Middle Woodland village and mound complexes (i.e., the Pinson Mound Group) exist near Jackson, Tennessee about 160 kilometers southeast of Hickman, Kentucky.

Overlapping with the northwestern prong of the O'Byam's Earthwork and mound 15Fu44 is the Middle Mississippian site, 15Fu45. Stahr Hill, as this site is known, extends northward from the Bayou de Chien bluff into the Bayou de Chien floodplain on the west and east sides of an old dirt road (sites 15Fu46 and 15Fu47, respectively). The two areas of occupation in the bottomland, however, represent two very small isolated house units as delineated by a surface scatter of daub, utilitarian Mississippian ceramic wares, and chipped stone tools. The major village and midden areas of 15Fu45 exist on top and south of the Bayou de Chien bluff area. No Middle Mississippian mounds are known to be directly associated with this rather large, spatially-extensive Middle Mississippian village area. The settlement pattern of the bluff-top site area appears to be of the dispersed style, which is a common feature of the Middle Mississippian period. Unfortunately, due to the rather severe degree to which this site has been looted, it is not possible to delineate specific house units.

Site 15Hi1 (McCleod's Bluff)*

The McCleod's Bluff site, 15Hi1, is a Late Phase Mississippian Period village, cemetery, central plaza, and mound site that probably dates between A.D. 1250 to A.D. 1350. The site covers an area of 57 hectares within the southwestern area of Hickman County, Kentucky. The UTM center point of this site is located in Zone 16, 4059420 Northing and 310380 Easting on the Oakton, Kentucky 1:24000 topographical quadrangle.

The site is situated on top of a northwest to southeast oriented ridge that is approximately 500 meters long and 100 meters wide. (Figure 8). At both ends of this ridge are truncated temple mounds, the largest of which occurs on the southeastern ridge terminus overlooking Obion Creek. That mound measures approximately four meters high, is 30 meters in diameter, and has a northwesterly facing ramp. Four historic graves occur on top of this mound, which like the other two mounds, is covered with secondary tree growth.

Southwest and adjacent to the ridge system is a portion of the Obion Creek floodplain which does not contain items of material culture and which may have served as either a small farming area or central plaza. In the extreme southeastern portion of this floodplain is a very impressive, conical-shaped mound that rises almost nine meters above the floodplain. The basal area of this mound encompasses almost five hectares.

Like the majority of other major Mississippian sites, 15Hi1 has been severely looted. Unlike other sites, the looting at Hi1 appears to have been concentrated on the combined village and cemetery (non-mound) region of the site area that is located north of and adjacent to the mound overlooking Obion Creek. Except for the floodplain/plaza and central ridge area of this site, the majority of 15Hi1 is completely covered with secondary and subcanopy forest growth, making surface visibility poor at best.

Site 15Hi14*

Site 15Hi14 is an extremely large open habitation site of the Woodland Tradition. The total site area encompasses 11.6 hectares on top of a large bluff system that overlooks the Mississippi floodplain (Figure 9). The approximate center UTM point of this site is Zone 16, 4062360 Northing and 310340 Easting on the Oakton, Kentucky 1:24000 topographical quadrangle.

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Figure 8. CIR of 15Hil. (North is at top of page)

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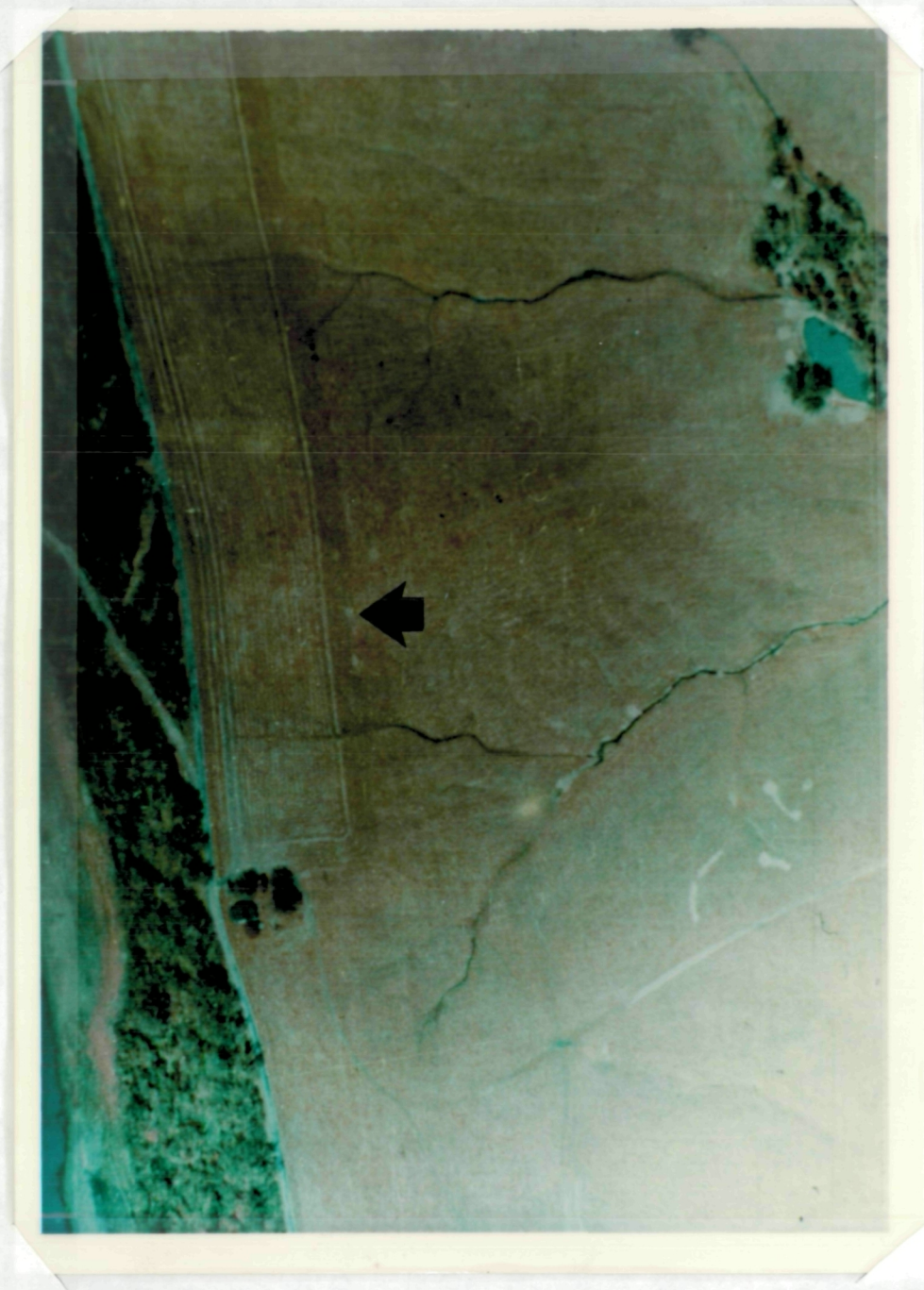


Figure 9. CIR of 15Hi14. (North is at top of page)

Although the site is very extensive, next to nothing is reported about this site in the Office of State Archeology (OSA) file other than its Woodland Tradition affiliation and spatial extent. Whether or not midden is present at this site is not known, however, the CIR imagery of the site does indicate very positive plant growth is present. "Something" is indeed causing accelerated plant growth in the site area, however, modern farming practices and/or natural subsurface conditions might be the cause rather than prehistoric midden deposits.

Site 15McN1 (Shawnee Mounds)*

This site is represented by two mounds as well as a considerable number of smaller, unreported specific site locations that exist within a general 2.5 hectare area. Unfortunately, the OSA refuses to reassign additional site numbers to this region, which only adds to the confusion of what constitutes site 15McN1. Be that as it may, 15McN1 for this project represents two small Woodland Tradition mounds that probably date between A.D. 600 and A.D. 900, based on the presence of Baytown Plain ceramics found on the surface of both mounds. The mounds, which measure about six meters tall and cover an area of 1.25 hectares each, are located about 2.5 kilometers north of Rossington, Kentucky (Joppa, Illinois-Kentucky, 1:24000 topographical quadrangle), along the southern periphery of the Ohio River floodplain. The mounds are situated along tributaries of Snake and Deer Lick Creeks at an elevation of about 100 meters above sea level. The two mounds are located 1.4 kilometers apart. The eastern mound's center UTM coordinates are Zone 16, 4114480 Northing and 337960 Easting; the western mound's coordinates are 4115250 Northing and 336850 Easting.

Both mounds have been disturbed (the tops of each have been leveled by bulldozers) (Figure 10). Prehistoric cultural materials, e.g., Baytown

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Figure 10. CIR of 15McN1. (North is at top of page)

Plain ceramic fragments and chipped stone detritus, occur scattered randomly around both mounds. According to Dr. Kit Wesler (personal communication), who has ground truthed this "site" area, there is a sporadic, but continuous distribution of cultural materials (including Archaic and Mississippian cultural items) occurring along the entire bluff between both mounds. Hence, not only is it doubtful that both mounds are related temporally and spatially, but it would appear that this particular region was a frequent "site area" for many different cultures between 8000 B.C. and A.D. 1350. And, although these mounds are classic examples of Woodland mound building, a considerable amount of field survey and analysis is needed in this area before anything definite can be stated about the mounds.

Site MxV1/PpV1 (Kincaid Mound Complex)*

Next to the very large prehistoric Mississippian urban center of Cahokia, the Kincaid Mound Complex is probably the second or third largest site in the southeastern United States (Figure 11). It was probably occupied most noticeably between A.D. 1250 and 1350, making it a Late Phase Mississippian settlement.

The site complex is located in extreme southeastern Massac and extreme southwestern Pope counties in Illinois, lying just opposite the confluence of the Tennessee and Ohio Rivers and adjacent to the northern periphery of Avery Lake, a post-Pleistocene Ohio River slough. The entire site complex stretches for more than 1.5 kilometers in length along its southwest to northeast axis. An approximate UTM center coordinate for this site complex is Zone 16, 4104600 Northing and 367200 Easting. The western periphery of the site is present on the Paducah East, 1:24000 Kentucky-Illinois topographical map, while the eastern two thirds of the site is present on the Little Cypress Creek, 1:24000, Kentucky-Illinois topographical map.

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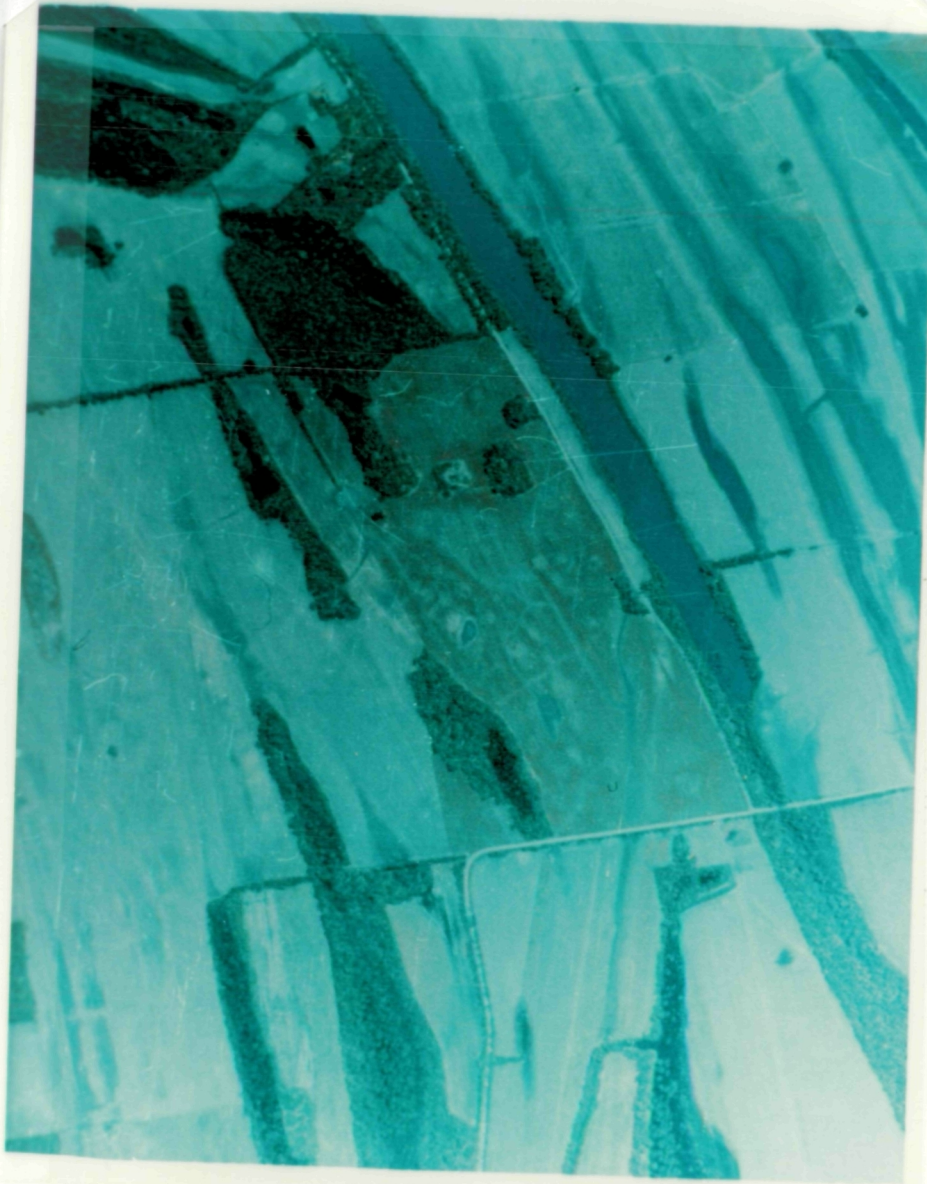


Figure 11. CIR of 11Mx^V/11Pp^{V1}. (North is at top of page)

A considerable amount of archeological research has been conducted at the Kincaid complex, beginning as early as 1934 and continuing until present. Initial studies were conducted by the University of Chicago¹ through 1950 at which time studies were only briefly interrupted before being continued by Southern Illinois University. In addition to the Kincaid site area, SIU archeologists have thoroughly surface surveyed and recorded every site within a ten kilometer radius of Kincaid (Muller, SIU/Department of Anthropology, personal communication).

Kincaid proper, consists of more than 20 mound structures, numerous barrow pits, several very large stockades with bastions spaced at regular intervals, at least one stone box grave cemetery, numerous house platforms, a very large central plaza, at least one possible garden plot, and isolated, dispersed and nucleated village (hamlet?) units. Kincaid is a very complex site.

Despite the enormous amount of area contained within the field excavations at the Kincaid site, probably less than 1% of the total site has been studied and even less has been analyzed. Despite such a small excavated sample, more is known about Kincaid than most sites which are much smaller. This does not mean that archeologists fully understand or comprehend Kincaid. On the contrary, the interpretation of Kincaid is very controversial. Some archeologists interpret the site as having been a center of trade and commerce; its officials paying homage only to the "city" of Cahokia. Those believers interpret the sites' many house structures as having supported upwards of 2000 people at any one time. Then there are those who have interpreted Kincaid as a large urban center,

¹Kincaid: A Prehistoric Illinois Metropolis. Fay-Cooper Cole, et al., 1951. The University of Chicago Press, Chicago.

populated primarily by a limited number of secular elite who were economically supported by very small, agriculturally-oriented, non-nucleated, outlying hamlets and villages; the size of Kincaid never exceeded 200 or 300 individuals at any time. Whichever interpretation is correct - if either - much still needs to be done at Kincaid. The overwhelming number of observable structures and other cultural features at Kincaid continue to make it a very unique site.

Procedure

The following is a review of the procedures applied to those sites which were subjected to detailed digital processing as noted above in the Archeological Site Description. As mentioned previously, these sites were deemed to be "type" sites based on their physical characteristics. Data were processed using the NASA/ERL software package ELAS. Detailed analysis included the use of ten meter TMS data only. Information in parenthesis refers to modules within ELAS.

I. Initial data processing

- A. Viewed all channels of flight line 1 and flight line 2 (COMD)
- B. Found amplifier gain change in channel 4 of flight line 1
(COMD) (Used data beyond gain change along flight line)
- C. Replaced pixel dropouts in channel 7 (BRUM)
- D. Corrected data for cross-scene illumination effects (RAMP, DRMP, CRSX)

II. Selection of usable channels

- A. Viewed deramped data (COMD)
- B. Outputted tabular histograms showing distribution of values in all channels (PLYA)

- C. Outputted values in all channels surrounding archeological sites (DUMP)
- D. Computed correlation matrix for all channels (GASP)
- E. Determined which channels to eliminate based on steps 1 through 4 above as follows:

1. Flight line 1:

- a. Eliminated channel 3 due to saturation as 3.785 percent of pixels were value 255 (Table 3)

Table 3. Results of Tabular Histogram for Flight Line 1
Showing Number of Pixels and Percent Total Pixels
With Value of 255 for 10 Meter TMS

| <u>Channel</u> | <u>Total Pixels</u> | <u>% Total¹</u> |
|----------------|---------------------|----------------------------|
| 1 | 1,813 | 0.114 |
| 2 | 18,556 | 1.164 |
| 3 | 60,339 | 3.785 |
| 4 | 2,247 | 0.141 |
| 5 | 5,466 | 0.343 |
| 6 | 489 | 0.031 |
| 7 | 1,440 | 0.090 |

¹Total pixels in flight line 1 - 1,594,080

- b. Eliminated channels 2 and 5 based on their high correlation with channels 1 and 6, respectively (Table 4)

Table 4. Correlation Matrix for Flight Line 1, 10 Meter TMS

| Channels | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|----------|-------------|-------|-------|-------|-------------|-------|-------|
| 1 | 1.000 | | | | | | |
| 2 | <u>.939</u> | 1.000 | | | | | |
| 3 | .892 | .960 | 1.000 | | | | |
| 4 | .189 | .203 | .171 | 1.000 | | | |
| 5 | .296 | .272 | .320 | .836 | 1.000 | | |
| 6 | .455 | .437 | .481 | .750 | <u>.964</u> | 1.000 | |
| 7 | -.160 | -.240 | -.235 | .471 | .523 | .467 | 1.000 |

c. Channels 2, 3, and 5 also had a higher proportion of 255 values than the remaining channels.

2. Flight line 2:

- a. No channels were eliminated based on the number of pixels with a value of 255 - maximum was 1.27 percent in channel 2
- b. Eliminated channel 6 based on a high correlation with channel 5 (Table 5) and severe stripping

Table 5. Correlation Matrix for Flight Line 2, 10 Meter TMS

| Channels | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|----------|-------|-------|-------|-------|-------------|-------|-------|
| 1 | 1.000 | | | | | | |
| 2 | .912 | 1.000 | | | | | |
| 3 | .920 | .964 | 1.000 | | | | |
| 4 | -.045 | -.057 | -.042 | 1.000 | | | |
| 5 | .146 | .019 | .124 | .809 | 1.000 | | |
| 6 | .269 | .126 | .239 | .721 | <u>.976</u> | 1.000 | |
| 7 | -.100 | -.208 | -.133 | .656 | .811 | .763 | 1.000 |

c. Eliminated channel 7 on basis of severe stripping

III. Collection of statistics and classification

- A. Passed 3 x 3 window through data sets to acquire homogeneous training field statistics (SRCH)
- B. Classified all data sets with maximum likelihood classifier based on classes determined in the step above (MAXL)
- C. Collected training statistics by point clustering within polygons drawn around known archeological sites (PTCL)
- D. Classified all data sets with maximum likelihood classifier using classes determined in the step above (MAXL)

IV. Further classification techniques

- A. Collected training statistics by point clustering within classes established by previous classification (WCCL)
- B. Classified data in specific classes with maximum likelihood classifier according to classes determined in step above (WMAX)
- C. Collected training statistics by point clustering within certain pixels in a range of values of one channel which corresponded to archeological features (WCCL)
- D. Classified data in a range of values of one channel which corresponded to archeological features with maximum likelihood classifier according to classes found in step above (WMAX)
- E. Executed a supervised spatial classifier which searched for spatial relationships between various classes derived from previous point cluster or within class cluster routines. This algorithm searched for a specific class which was surrounded by another specific class.

Results

The results presented below reflect the various types of analyses which were utilized with respect to each of the archeological sites listed in Table 1 and described in the Archeological Site Description.

15Ba2 (Twin Mounds): This site consisted of two tree-covered mounds and a village site which was a tilled field. It was easily visible in stereo on the high altitude CIR as the mounds rose above the surrounding flood plain. A slightly darker-toned soil distinguished the village area, but this darker tone was no different from surrounding dark-toned soil which had a higher moisture content due to its location along drainage lines. TMS data was available at 30 meters only. An unsupervised classification was run in the area with no separation of the tree-covered mounds from other forested land or the village site of bare ground from other plowed fields.

15Ba18, 21, 29, 30: This group of sites is characterized by their location on very low ridges (terraces) which rise less than two meters above the surrounding floodplain. There are no known permanent structures associated with Ba18. Sites 15Ba21, 29, and 30 may have had single wattle and daub house structures, however, no specific structural features were located during ground truthing. All of the sites were located in areas of bare ground. The low ridges on which these (and many other) sites (small permanent isolated house features and non-permanent camp sites) were located were easily distinguished on the CIR as very light-toned soils. An unsupervised classification was run on 10 meter data resulting in classes which depicted the low narrow ridges. This, of course, does not mean that all ridges in the area contain archeological sites, nor was a signature distinctive of occupation realized. However, such a result could certainly narrow an area to be intensively field-checked if an archeological survey

were to be conducted. It should be mentioned that these low ridges or terraces are very common throughout the floodplain region and that occupation of such zones is certainly extensive along the Ohio and Mississippi Rivers.

15Ba105: 15Ba105 is a village site located in a grass-covered field which also includes some small trees. The CIR gave some clue as to the location of the site showing vegetation with slightly more vigor in the village site area. No digital processing was performed over this area as other sites processed were of the same character.

15Fu4: The Adams Mound complex is located on an area of high ground in the Obion River floodplain, a tributary of the Mississippi River. It is a large site consisting of a village area now in grass and three tree-covered mounds. The site area was easily identified in stereo on the CIR due to its height above the surrounding floodplain. A very interesting feature was noted on the low altitude CIR - the remains of "pot-hunters" pits. These pits were detected by vigorously growing patches of vegetation which were in place on recently turned soil. The visible pits were scattered and approximately two to five meters in diameter. Point cluster (PTCL) and within class clustering (WCCL) were applied to the Adams Mound complex. No distinctive archeological signature was extracted. The mounds were revealed as a variety of forest classes which are widely distributed in the area (see Appendix A). The "pot-hunters" pits were too small to be detected at 10 meter resolution.

15Fu37-50: The O'Byam's Fort/Stahr Hill complex is an area which contains a number of structures including mounds, a "tuning fork-shaped" earthwork, and two, temporally distinct, large midden areas associated with permanent village sites. The CIR revealed the mounds as areas with sparse wheat growth. Midden areas were covered by vigorously growing wheat. This

vigorous growth could also have been the result of fertilization. Both the point cluster (PTCL) and the within class cluster (WCCL) were applied to these areas with no distinctive archeological signatures being extracted. Classes which were associated with the vigorously growing wheat in the mid-den areas were also widespread in other wheat fields. A supervised spatial classification algorithm (see Procedures) was applied to two of the mounds in the area which had a very sparse wheat cover. Again, many areas depicting the same spatial relationship were classified along with the mounds (see Appendix A).

15Hi1: McCleod's Bluff is composed of three tree-covered mounds and a village-cemetery site located in grassland (the village-cemetery area has been looted almost totally by pot-hunters). It was not possible to distinguish any of the site structures on the CIR due primarily to the fact that the mounds are tree-covered and located in hilly terrain; they could not be distinguished from other tree-covered high areas. Point cluster (PTCL) technique was applied to the mounds with no distinctive archeological signature being recognized (see Appendix A).

15Hi14: 15Hi14 is a village site with no major structures located in a pastureland/grassland situation. Interpretation of the CIR revealed a somewhat brighter response in the village site area which may have been due to the type of grass or soil in the area and/or the presence of organic midden. Point clustering (PTCL) and within class clustering (WCCL) were applied to the area with no distinctive signatures being extracted (see Appendix A).

15McN1: Shawnee Mounds consists of two mounds and a possible village site(s). At the time of the flyover, both mounds were easily distinguished on the CIR by their relief above the surrounding floodplain and by their very high reflectance due to the light-toned, dry soil associated with

them. Of all features analyzed, it was thought that these might truly reflect an "archeological signature" as there was no vegetative cover involved. However, after running both point (PTCL) and within class clustering (WCCL) and a form of spatial classifier, the mounds could not be distinctly separated from other areas of plowed ground. The classes remaining over the mounds and in other bare ground areas contained far fewer pixels after the various classification techniques were applied as was the case with various phenomena in other sites tested, but no distinct signature was evident (see Appendix B).

11Mx^{V1}/11Pp^{V1}: The Kincaid site complex includes a variety of archeological features - tree-covered mounds, mounds covered with stubble, village sites, house platforms, a possible garden plot, and a stockade line with bastions covered with varying amounts of grass and/or weeds. The tree-covered mounds were the most easily detected on the CIR although clues to the other structures were visible. Also visible on the CIR were large test pit areas which were excavated by University of Chicago archeologists beginning in the late 1930s. These areas exhibit a more sparse weed growth. Both point (PTCL) and within class clustering (WCCL) routines were applied to the site region. Again, no features associated with the prehistoric site complex were extracted due in large part to the fact that most of the site area was covered by varying densities of grasses/weeds (see Appendix B).

Conclusions

The following conclusions are related to the digital processing of TMS 10 and 30 meter, as well as the manual interpretation of CIR imagery. It should be emphasized that they are related to specific localities in the Ohio and Mississippi River valleys at a particular time. Analysis completed in other places or at another time may yield different conclusions.

1. CIR imagery was helpful in distinguishing sites of known location due to vegetative growth patterns, areas of bare ground such as terraces, and the stereo viewing of mounds. CIR could be used also to detect anomalous patterns which are not yet registered archeological sites.
2. The TMS 30 meter data was limited in use as most archeological features exceed this resolution. A few large mounds (15Ba2) and ridges upon which sites may be located (15Ba18, 21, 29, 30) were detected. No distinct archeological signatures were revealed.
3. TMS 10 meter data was more useful than 30 meter data in detecting known archeological sites because of the greater resolution. No archeological signatures were revealed. However, as successive classification schemes were run (WCCL or PTCL), the classes which depicted features associated with the various sites were more limited after each run.
4. Although no distinctive signatures were realized as the result of the digital processing of TMS data, the use of such data is not totally useless with respect to archeology. A trained archeologist/interpreter could perceive patterns, shapes, and the relative location of anomalies which are extracted by various classification techniques. Having such information could eliminate the possibility of a total field survey and direct the archeologist to specific areas of high probability. TMS data offer indirect evidence of possible site localities.
5. As classification results were reviewed, the utility of classified TMS data to other areas of resource management such as agronomy, forestry, or soil science was very evident.

Recommendations

1. Increase the resolution of the sensor as many features associated with the archeological sites in the study area exceed a resolution of 10 meters.
2. Employ digital elevation data (DEM) in association with high resolution TM data to detect isolated and/or anomalous topographic highs which might be archeological structures.
3. Utilize a sensor which gathers emitted rather than reflected data (TIMS) to eliminate some of the effects of vegetative cover on sites.
4. Concentrate research efforts on a "typical" single site complex which contains a variety of archeological features upon which much ground-based research has been completed. Develop a controlled predictive model and excavate after prediction to determine function of structural features.

APPENDIX A

Flight Line 2

Initial SRCH run yielded 71 classes. MAXL run classified all data according to those classes. Initial PTCL run yielded 44 classes. MAXL run classified all data according to those classes.

15Fu4 (Adams Mound Complex)

1. SRCH classes represented on site:

class 2: forest on mound edges
class 8: bare ground on mounds
class 27: bare ground/sparse vegetation on mound edges
class 30: forest on mounds

2. WCCL run on SRCH classes 8 and 27 yielded 14 classes.

3. PTCL classes represented on site:

classes 1-3: forest on edges of site area
class 4:
classes 8-11: } vegetation of varying densities on
class 26: } village area
class 37:
classes 43-44: }

15Fu37-50 (O'Byam's Fort/Stahr Hill Complex)

1. SRCH classes represented on site:

class 8: bare ground on mounds
class 9: vegetation on mound edges
class 15: vigorously growing wheat on midden areas
class 16: vegetation on mound edges
class 24: wheat on village areas
class 27: bare ground/sparse vegetation on mound edges
class 37: bare ground





2. WCCL run on SRCH classes 8, 9, 16, and 27 yielded 14 classes.
Classes represented on site:

class 1: mound tops
class 2: mound edges
class 4: mound edges

3. WCCL run on class 1 above yielded 4 classes.

APPENDIX A (cont'd)

4. PTCL classes represented on site:

classes 6-7:  bare ground/sparse wheat on mound tops
class 10: 
class 16:  wheat on mound edges
class 25: 

5. WCCL run on PTCL classes 6, 7, 10, 16, and 25 yielded 41 classes.
Classes represented on site:

class 4: wheat on mound edges
class 6: sparse wheat on mound tops

6. Supervised spatial classification run looked for adjacent pixels of specific SRCH classes. In this case, the run looked for pixels of SRCH class 8, surrounded by SRCH classes 9, 16, and/or 27.

15Hi1 (McCleod's Bluff)

1. SRCH classes represented on site:

class 2: forest on mound edges
class 10: grass on village area
class 12: trees on mound edges
class 28: trees on mounds

2. PTCL classes represented on site:

classes 1-3: forest on edges of site
class 20: forest on site area
class 44: trees on mounds

15Hi14

1. SRCH classes represented on site:

class 9: pasture on village area
class 25: grass on village area

2. PTCL classes represented on site:

classes 8-10: grass/pasture on village area

3. WCCL run on PTCL classes 8 and 9 yielded 6 classes.

APPENDIX B

Flight Line 1

Initial SRCH run yielded 59 classes. MAXL run classified all data according to those classes. Initial PTCL run yielded 14 classes for Kincaid site and 9 classes for Shawnee site. MAXL run classified all data according to those classes.

15McN1 (Shawnee Mounds)

1. SRCH classes represented on site:

class 6: bare ground on mound tops
class 54: bare ground on mound flanks
class 21: > vegetation surrounding mounds
class 24: >

2. WCCL run on SRCH classes 6 and 54 yielded 6 classes. Classes represented on site:

class 1: bare ground on mound tops
class 2: bare ground on mound flanks

3. WCCL run on classes 1 and 2 above yielded 9 classes. Classes represented on site:

class 1: > flanks of mounds
class 3: >
class 6: mound tops

4. WCCL run on classes 1 and 3 above yielded 5 classes. WCCL run on class 6 above yielded 5 classes.

5. PTCL run yielded 9 classes.

6. WCCL run clustering within pixels having a value of 242-255 in channel 3 (these values corresponded to mounds), yielded 23 classes. Classes represented on site:

class 7: > bare ground on mounds
classes 12-13: >

7. WCCL run on classes 7, 12, and 13 above yielded 6 classes. Classes represented on site:

class 1: > bare ground on mounds
class 2: >


APPENDIX B (cont'd)

8. WCCL run on classes 1 and 2 above yielded 4 classes. Classes represented on site:

class 2: bare ground on mound tops
9. Supervised spatial classification run looked for adjacent pixels of specific SRCH classes. In this case, the run looked for pixels of SRCH class 6 surrounded by pixels of SRCH class 54.
10. Another supervised spatial classification run looked for adjacent pixels of specific WCCL classes. In this case, the run looked for pixels of initial WCCL class 1 surrounded by WCCL class 2 (see No. 2 above).
11. Another supervised spatial classification run looked for pixels of secondary WCCL class 6 surrounded by WCCL classes 1 and/or 3 (see No. 3 above).

11Mx^{V1}/11Pp^{V1} (Kincaid Mound Complex)

1. SRCH classes represented on site:

class 1: bare ground
class 3: bare ground/sparse grass
class 6: highly reflective bare ground
class 8: high ground with vigorous vegetation growth
class 9: forest on mounds
class 21: low, wet ground with poor vegetation growth
class 22: grass/weeds
class 26: vigorous vegetation growth on mound edges
class 41: trees on mounds
class 45: 
class 49: grass/weeds of varying densities
class 56:

2. PTCL classes represented on site:

classes 2-3: trees on mounds
classes 11-12: bare ground/sparse vegetation

3. WCCL run on PTCL classes 2, 3, 11, and 12 yielded 33 classes. Classes represented on site:

class 7: bare ground
class 13: trees and vegetation on mounds
class 14: dense vegetation around mounds
class 15: dense vegetation, some around house platforms